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ABSTRACT

This teaching guide suggests practical ideas for encouraging mathematics talent in preschool children. It is part of a series of similar guides developed by the RAPYHT Project (Retrieval and Acceleration of Promising Young Handicapped and Talented) for educating gifted/talented handicapped children and gifted children with no handicaps. A list of characteristics of children with mathematics talent is provided. Suggestions are offered to help the teacher present a concept-oriented mathematics program to the talented preschooler. Lists of suggested materials for a mathematics center and resource books for the library are also provided. A description of specific goal areas and classroom activities for the mathematically talented child comprises the largest section of the guide. The following goals are focused upon: awareness of geometric shapes; understanding of sets, one-to-one correspondence and number value of numerals; counting skills; understanding of the operations of addition and subtraction; understanding of patterns, fractions, and time; understanding of measuring space, volume, and weight; and understanding of money and money values. An annotated list of resources is included. (CM)

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Nurturing Academic Talent In Early Childhood

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Math

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TABLE OF CONTENTS

	Page
Math Talent in the Preschool Years	1
Common Characteristics of Children with Math Talent	2
General Methods to Stimulate Math Talent	4
Goal Areas and Activities	11
Annotated List of Resources	27

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RAPYHT: A Model Program for Retrieval and Acceleration of Promising Young Handicapped and Talented

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Cynthia Mohrman is responsible for the art work and cover design which adds greatly to the appearance of the manual.

It is our hope that the suggestions in this manual will help teachers more effectively nurture talent among their charges and in addition, will motivate them to develop other activities for fostering talent.

Merle B. Karnes, Director, RAPYHT Project
Georgeanne F. McBride, Teacher
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FOREWORD

In the Fall of 1975 the Institute for Child Behavior and Development at the University of Illinois received a grant from the Federal Bureau of Education for the Handicapped (BEH) to develop and demonstrate a model program for the "Retrieval and Acceleration of Promising Young Handicapped and Talented" (RAPYHT). Children from three to five years of age were included in the project, which has completed the last year of a three-year demonstration cycle and is entering into the first year of outreach funding.

The principle goal of this project has been to develop and demonstrate an approach for educating young gifted talented handicapped children who are enrolled in programs that also serve gifted children with no handicaps, average children with no handicaps and multi-handicapped children who are of higher but not gifted ability. Since there are relatively small numbers of gifted handicapped children in any population, the approach has been to educate them in the mainstream, but, at the same time, provide them with special programming to meet the unique needs associated with giftedness and talent.

A major outcome of this three-year demonstration project has been the completion of a set of printed materials designed to aid classroom teachers and parents who desire to identify and encourage the development of the gifts and talents of young children, including those who are handicapped. This set of materials includes guides for screening, assessing and programming for children in the areas of intellectual, academic (reading, math, science), creative, leadership, visual and performing arts (art and music), and psychomotor talent. These materials are applicable for use with young gifted/talented children as well as those who are gifted/talented with handicaps. In fact, every child has a measure of talent which may go underdeveloped unless identified and nurtured. Therefore, we are convinced that careful observation and programming in talent areas is important for all children.

We are also committed to the premise that the earlier we identify and program for talents the greater the chances that the child will fully develop his true potential. Nationwide, there have been relatively few efforts devoted to identifying and programming for young gifted/talented and even less for the gifted/talented handicapped. Hopefully, the products developed by the RAPYHT Project will create more awareness of the need to identify and program for this neglected segment of our population.

Merle B. Karnes, Ed.D.
Director of RAPYHT Project

MATH TALENT IN THE PRESCHOOL YEARS

Over the past two decades there has been a revolution in the teaching of mathematics. Part of this can be attributed to the application of educational research to the mathematics curriculum. Two recent and important discoveries are: 1) children can deal with mathematical concepts at an earlier age than previously thought (Leeper, 1974 and Smith, 1967), and 2) children can and will discover mathematical concepts for themselves when led to discover the contributions of mathematics to their lives (Leeper, 1974).

According to Gallagher (1975), one of the major educational goals for a student gifted in mathematics is that the child understand that math is comprised of intricate patterns of related concepts. This means less emphasis on drill and memorizing facts which may be boring or trivial for the bright student and a greater emphasis on the relationships of the concepts underlying mathematics. This also means that the discovery method, where the child becomes an active problem-solver, should be used to facilitate understanding of these concepts. Secondly, students gifted in mathematics should be shown that math is not a static subject confined to math sessions in school. Instead, math is a meaninful and dynamic area which he/she can apply to his/her daily life in many creative and innovative ways, from the use of measuring devices and addition skills for building and cooking activities to the use of division and fractions for dividing a special treat among friends.

COMMON CHARACTERISITCS OF CHILDREN WITH MATH TALENT

1. The child shows a strong interest in math-related activities such as counting, weighing, measuring or solving arithmetic problems. For example, he/she may volunteer to compute the number of carrot sticks needed for snack or the child may enjoy measuring ingredients for cookie batter of playdough.

2. The child has a long attention span for math activities. He/she might become absorbed in a classroom math game or spend an unusually long time weighing objects, matching numbers and numerals or using a ruler.

3. The child shows advanced understanding of mathematical relationships. For example, he/she might comprehend the concept of "set" and "one-to-one correspondence" quickly or he/she might show a clear understanding of relationships between numbers by adding and subtracting.

4. The child understands and easily remembers mathematical symbols. These symbols include numerals, operation signs (+, -, x, ÷) and relationship symbols (=, >, <).

5. The child manipulates numbers easily. He/she might perform mental or written addition and subtraction problems, count by two's or three's, or he/she may be able to add and subtract coin values in a play store situation.

6. The child shows an interest in or has advanced understanding of concepts such as time (calendars and clocks) or money (coin values, making change).

7. The child often generalizes math concepts to activities and projects other than math. For example, he/she might equally divide a cookie to share with someone else, read the clock to tell when it's time to go outdoors, or independently compute how many days are left until a special event.

GENERAL METHODS TO STIMULATE MATH TALENT

The child with mathematical talent should view math as a usable tool. This is only possible if he/she understands the concepts behind every math fact he/she learns. The following are some suggestions to help present a concept-oriented math program to the talented preschooler.

1. Present math concepts in an ordered sequence. Curriculum resources will help you determine the order to present various concepts. Some possible resources are: Baratta-Lorton (1976), Karnes (1973), and Stern (1966). Make sure that the child thoroughly masters one concept before going on to another. Although the child with math talent will probably learn these concepts at an accelerated rate, he/she will still need to learn the material in a logical sequence.

2. When you introduce a concept, use concrete materials that the child can manipulate. After the child masters the concept using three-dimensional materials, present the same idea with semi-concrete materials such as pictures. Finally, have the child work with abstracts such as numerals and mathematical notation. For example, introduce fractions by having the child divide concrete objects, (oranges, pieces of paper, symmetrical clay shapes). Eventually, have the child draw lines to divide pictures of symmetrical objects, (balls, cakes, squares). Gradually, introduce the numerical notation for fractions.

3. Present each concept in a variety of situations. For example, if the child has used a measuring stick to compare the heights of two people, have him/her use the stick to compare the lengths of two tables or the heights of two sand towers, or the distances two

children have broad jumped. When the child uses a concept in a variety of ways, he/she understands it better and remembers it more easily.

4. Math requires a great deal of practice and overlearning. It is not necessary to bore the child with dull drills. Use his/her imagination and your own to divise exciting ways to practice counting, labeling shapes and numerals, addition and subtraction tables, etc. The activities section of this guide and many of the sources listed suggest fun ways to practice math facts and tables. Make sure that the child understands the concepts involved before he/she memorizes any mathematical facts. For example, before the child memorizes that 2 + 2 = 4, make sure that he/she understands that 2 monsters + 2 monsters = 4 monsters.

5. Emphasize creative problem-solving as much as possible. Encourage the child to find answers to math questions in his/her own way. For example, don't show the child how to divide a banana in half. Rather, ask him/her how to divide the banana so that he/she and another child will each have the same size piece. Whenever possible, encourage the child to solve a problem in several ways. For example, after the child has sorted a group of buttons by color, challenge him/her to think of another way to sort the buttons. He/she might categorize them by size, shape, number of holes, or texture.

6. Help the child see how different concepts are related. If you are teaching a child how to find the sum of two numbers using addition,

challenge him/her to also find the sum by counting or to demonstrate the problem with blocks.

7. Help the child experience success in mathematics. If he/she has rewarding math experiences, the child will feel secure about exploring math concepts. This is especially important for girls who, even at the preschool age pick up subtle cultural messages that mathmatics is more for boys than girls (Gallagher, 1975). This does not mean that the child should never fail. But you can help him/her learn from an unsuccessful experience by encouraging him/her to find ways to reanalyze or rework the problem. For example, if the child decides that he/she needs 8 carrot sticks in order to give 2 to each of 5 children, let him/her pass out the carrot sticks and see for him/herself that there are not enough. Then encourage him/her to recalculate the total number needed.

8. Help the child learn the language of math by using it yourself. Use comparison words during snack, building activities, cooking and craft activities. For example, "Who has more raisins than you, Tom?" "You can have part of that big piece of cardboard." "Your clay sculpture is a lot heavier than Joan's!" Introduce more technical terms when you introduce the related concept and then use the term in your conversations with the child. "Right! If you put another rock in the aquarium there will be six. Five plus one equals six." "Cut this banana in half and share it with Chris." If you use technical terms before the child has learned the concepts they describe, you will only confuse the child.

9. Help the child see the social and practical applications of concepts and systems of concepts. You might help the child use the calendar to calculate how many days until a specific event such as his/her birthday, a holiday or a class field trip. Or you might have the child figure out if the class has enough money to buy a class pet or a special snack. Baking and building activities offer many opportunities for the child to use his/her math skills. Encourage him/her to use all kinds of measuring tools: measuring sticks, measuring cups and spoons, thermometers, and scales. If the child realizes the practical uses for math, his/her interest will become keener.

10. Evaluate the child often, and ask yourself the following questions: How well does he/she understand the concept he/she is working with? Are the activities/materials motivating? How could you challenge the child to use his/her knowledge in new ways? What are some practical applications of the concept?

11. Encourage the child's parents to challenge him/her with real life problems. It is not necessary for them to tutor their child in formal math procedures. But they can help the child become more adept at problem-solving and realize the usefulness of mathematics by having him/her use math in everyday experiences. "If it gets dark in two hours and we will arrive at grandma's house in one hour, will we be there before dark?" "Are there enough chairs for everyone?"

"Let's time how long it takes you to get dressed." "If the ball costs 90¢, do you need more than $1.00 to pay for it?"

Materials and equipment

One way to provide the mathematically talented child with a large number of enriching experiences is to have one area in the room where a wide variety of math related materials are readily available for the child to manipulate and explore. These experiences can provide the child with many practical applications of mathematical processes and concepts. Materials included may range from structured materials such as Cusenaire rods to informal materials found in the home such as bottle caps, egg cartons and buttons.

The following is a list of suggested materials for a mathematics center:

- thermometers--laboratory, outdoor, candy, etc.
- scales--old bathroom scales (2) for comparing weights, balance scales
- calendars
- puzzles with geometric inserts
- measuring containers of various sizes: measuring spoons, cups, quart containers, gallon jugs, metric measures
- sets of beads and strings
- blocks of different sizes and shapes
- toy money
- cardboard clock
- stop watch
- alarm clock
- egg timer
- various types of dials
- dominoes
- rulers, yardsticks, tape measure
- games
- articles for counting such as buttons and beads
- abacus
- number line
- felt cutouts of various sizes, colors, shapes and numbers
- pegboard, flannel board and magnetic board

Books can also be used as a resource. In addition, poems, pictures and other pictoral materials may be very valuable for helping the child

increase his/her math vocabulary. The following are some possible books to include in the class library.

Allen, R. Numbers. New York: Platt and Munk, 1968. (counting and advanced counting concepts)

Anderson, L. and Adams, A. Two hundred rabbits. New York: Viking Press, 1968. (grouping by tens)

Barr, K. Seven chicks missing. New York: Henry L. Walch, 1962. (counting backwards)

Becker, J. Seven little rabbits. New York: Walker & Co., 1973. (counting backwards from seven)

Bishop, C. Twenty-two bears. New York: Viking Press, 1964. (counting)

Brenner, B. The five pennies. New York: Alfred A. Knopf, 1964. (subtraction)

Brown, M. One two three: An animal counting book. Boston: Little, Brown and Co., 1976. (counting to 20)

Francoise. What time is it, Jeanne-Marie? New York: Scribner, 1963. (telling time)

Friskey, M. Mystery of the farmer's three fives. Chicago: Children's Press, 1963. (basic addition number combinations)

Mack, S. 10 Bears in my bed. New York: Pantheon, 1974. (counting backwards from ten)

Mendoza, G. The scarecrow clock. New York: Holt, Rinehart, and Winston, 1971. (reading a clock)

Myller, R. How big is a foot? New York: Atheneum, 1962. (measuring with markers)

Oxenbury, H. Numbers of things. New York: Franklin Watts, Inc., 1968. (counting to 50)

Schlein, M. It's about time. New York: Young Scott Books, 1955. (time)

Thayer, J. The little house. New York: William Morrow and Co., 1972. (sets and one-to-one correspondence)

GOAL AREAS AND ACTIVITIES

This section includes specific goal areas and classroom activities for the mathematically talented child. The following goals are adapted from GOAL PROGRAM: MATHEMATICAL CONCEPTS developed by Dr. Merle B. Karnes.

A. To increase awareness of geometric shapes

1. Cut shapes from different colored construction paper and have the child use them to make a picture of design. Encourage the child to make as many different pictures as possible.

2. Have a treasure hunt where the child must find shapes in objects around the room such as a clock for a circle and the back of a piano for a rectangle. Record each response and make a chart showing what objects were found for each shape.

3. On the floor place a piece of paper that has various shapes drawn on it. Make two decks of cards--one for body parts (hand, foot, elbow, knee, finger, heel) and the other for shapes. Have the child pick one card from each deck and follow the directions by moving only the body part shown on one card to touch a shape as shown on the other card. This lesson may be made more complex by using unfamiliar shapes such as an octagon or incorporating one shape inside another.

4. Give the child a long piece of rope and have him/her make different shapes with it. Vary the activity by cutting a length of cord about 1 meter long and tying the two ends together. Have two or three children put their hands on it and manipulate it to make a hexagon, three triangles, two circles, etc.

B. To increase understanding of sets

1. Make a set monster from a cardboard box. Paint eyes and a nose on the lid. Make a mouth with the upper lip drawn on the top of the box and the lower lip drawn on the edge of the box below. Explain to the child that the box is a set monster that eats only sets of objects such as a set of pencils or a set of round red objects. Have the set monster tell the child what set it wants to eat. When the child has found the articles encourage him/her to say that she/he is feeding the monster a set of pencils, a set of round red objects, etc. Have the child think of other sets the monster can eat and feed them to him.

2. Have several children divide themselves into sets. Model this activity at first by grouping them into a set of dark haired children and a set of blonde children. Explain to them what you are doing and have each set of children stand together in a group. Then challenge them to regroup themselves into different sets. They might become a set of children wearing tennis shoes, a set of those wearing sandals and a set of children wearing street shoes, or they might become a set of boys and a set of girls or a set of four-year-olds and a set of five-year-olds.

3. Have the child sort groups of objects by making up his/her own description of various sets. At first, model this activity for the child and use the term "set" to describe each group. "I have some rocks I want to sort. I'll put the red rocks over here and the gray ones here. Now

I have a set of red rocks and a set of gray rocks. What's a different way I could sort these rocks?" Challenge his/her creativity by asking the child to think of several ways to sort each group of objects. He/she might sort a group of rocks by size, shape, weight, etc. Vary this activity by asking the child to let you guess what the sets are after he/she has sorted a group of objects.

4. Have a group of children divide themselves into sets. Then have each set of children divide themselves into subsets. For example, the children might divide themselves into a set of children with long hair and a set with short hair. Then the long-haired set might become a subset of long, curly-haired children and a subset of long, straight-haired children.

5. Present a picnic basket full of eating utensils and food. Explain to the child that there are two large sets contained in the basket--a set of eating utensils and a set of food. Have the child sort the objects into the two sets. Then help the child sort each major set into subsets. For example the set of eating utensils can be sorted into subsets of knives, forks, etc. and the set of food into subsets of things to drink, fruit, vegetables, etc.

6. Give the child a paper cup containing five raisins and tell him/her that she/her has a set of five raisins. Have the child eat one raisin. Explain that the child now has a set of four raisins. Have the child repeat eating the raisins until all the raisins are gone. Ask the child how many raisins are now contained in his/her set of raisins.

Explain that a set without any members is called the empty set. Have the child think of other empty sets such as all the elephants in the room, or all the children ten feet tall. You might need to suggest some empty sets yourself at first to give the child the idea.

7. When you are looking at a picture book with the child, have the child find sets of objects in the pictures. For example, in one picture he/she might see a set of horses, a set of trees and a set of flowers.

8. Have the child guess "set" riddles. Describe a set and have the child name members of that set. "I am thinking of a set of things that have legs." or "I am thinking of a set of things that crawl." Encourage the child to name many members of each set.

C. <u>To increase understanding of one-to-one correspondence</u>

1. Have the child sit on one side of a table with a variety of objects in front of him/her. You sit on the other side with the same number of objects in front of you. Tape one end of a piece of string to one of the objects in front of you. Have the child tape the other end of the piece of string to an object in front of him/her. Repeat the activity until each of the objects is connected to another one with a piece of string. Don't give a reason for connecting any of the objects. The child might want to make up reasons anyways; for example, "I'll connect the wheel to this can so it can have another wheel."

2. Repeat the above activity and ask the child to state a reason whenever he/she connects two objects. After the child has finished the activity have him/her repeat it by connecting each object to a different object than the first time.

3. Repeat the activity with uneven numbers of objects, so that one group (set) has one or more members left over. Introduce the terms "more" and "less." "Your set has more members than mine."

4. Provide paper and pencil activities in which the child draws lines to connect the members of two sets. Tell stories or have the child make up stories to accompany the activitiy. For example, have the child connect members of the following two sets:

(monkeys) (bananas)

when you tell a story about two monkeys who are looking for a tasty snack. The Little House by J. Thayer is an excellent introduction to this activity.

D. To increase understanding of the number values of numerals

1. Play lotto games in which you hold up a card with dots and the child places a marker on the appropriate numeral on his/her lotto card. Include the numeral zero.

2. Place from ten to twenty objects in ten paper bags and on the outside of each bag, print the numeral corresponding to the number of objects inside. Show the child the bag with the numeral 10 printed on it and say, "Show me a bag which has more objects in it." When the child

has chosen a bag, have him/her count the objects in each bag to see if he/she chose correctly. Then repeat the activity several times. Sometimes ask the child to show you a bag with more objects than the one you chose and sometimes ask for one with less objects in it. Reverse roles with the child.

3. Set up a play store situation with price tags on each item in the store. Prices may vary from 1¢ to two or three digit price numbers depending on the ability level of the child. Use toy pennies as money and have the child count out the number of pennies corresponding to the price marked on each item he/she buys.

E. To increase counting skills

1. Challenge the child to count to a certain number and stop. "Count to six and stop."

2. Tell the child to count from a certain number. "Count on from three."

3. Tell the child to count from one number to another. "Count from seven to fifteen."

4. Challenge him/her to count backwards from a specific number. "Count backwards from twelve."

5. Have the child count backwards from one number to another. "Count backwards from nineteen to thirteen."

6. Teach the child to count by 2's or 3's. At first, this will be a memory task. When the child is skilled at rote counting by 2's or 3's,

have him/her count objects and then pictures of objects.

F. To increase understanding of the operations of addition and subtraction

1. Give the child five blocks and ask him/her how many blocks he/she has. Separate the blocks into two groups such as three and two. Ask the child if she/he still has the same amount of blocks. Encourage the child to group the blocks into different combinations that add to five. Repeat the procedure with a different number of blocks.

2. Play a game such as a ring toss game and have the child keep a tally of his/her own score. Provide a number line for the child to use as an aid while he/she adds. You might have the child place a marker on the numeral corresponding to his/her score and add on from there after each turn.

3. Make a board game with a path divided into spaces:
Have each player throw two dice and add the number of dots on the dice to compute how many spaces to move. Have the players repeat the procedure until someone reaches the end of the path. More complicated board games (those requiring players to move backwards, skip ahead or give up turns) are usually too confusing and take too long for preschoolers.

4. Show the child a number of small trinkets. Then hold them behind your back and put some in one hand and some in the other hands. Show the child the trinkets in one hand and ask how many are in the other. If the child says the correct number, let him/her have a turn to hide

the trinkets. If he/she says the wrong number, show the child the trinkets in the other hands and have him/her tell you how many there are. Then repeat the procedure, putting the same number of trinkets in each hand.

5. Give the child a number of toy ducks or markers and tell him/her that he/she is the farmer who owns these ducks. Tell the child that you are a fox who wants to steal the ducks and eat them. Then have the child pretend that he/she is asleep. While the "farmer" is asleep take away some of the toy ducks. Tell the child to wake up and figure out how many of his/her ducks are gone. If the child says the correct number, give the ducks back to him/her. If the child says the wrong number, help him/her visualize the problem using the toy ducks and recalculate the number missing. After several turns, trade roles with the child so that you play the farmer and he/she plays the fox.

6. Teach addition notation in a way that involves the child. Have him/her count with you as you put objects in a can. Then have him/her print the corresponding numeral for that number of objects. Put one more object in the can, saying, "plus one," and show him/her how to print the appropriate notation (+1). Have the child say, "equals" and print "=," and then fill in the sum. Use a method such as this to teach subtraction notation also.

7. Make an attendance chart for the classroom. List all the children's names. Below the names write this equation:

All the children in the class	-	Children here today	=	Children absent

Under the word equation write the action number of children enrolled and make slots to insert the correct numeral cards each day to complete the subtraction problem.

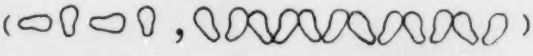
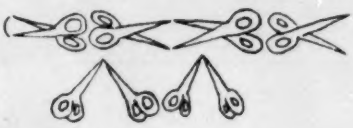
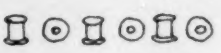
8. Place two stacks of number cards face down on the table. In the middle of the two piles place (face up) a card with either a plus or a minus sign. Have the child turn over a card from each pile and perform the correct operation of addition or subtraction. When using the minus sign make sure that the lowest number in the left pile of cards is higher than the highest number in the right pile of cards. This avoids getting negative numbers as answers.

9. Use flannel board characters to illustrate word problems. For example, display a flannel board house, ladder and human figure and act out the following problem. "This house is 10 units high. Jane's ladder is 8 units tall. Can Jane reach the roof of the house by climbing up this ladder?"

10. Introduce the child to the answer puppet which gives answers and never asks questions. Have the puppet tell the child a number. Have the child think of addition or subtraction statements which would combine to make that number. If the child has difficulty with this activity, give him/her concrete objects such as counting blocks to help him/her find a correct combination of numbers. Help the child print the corresponding addition or subtraction statement.

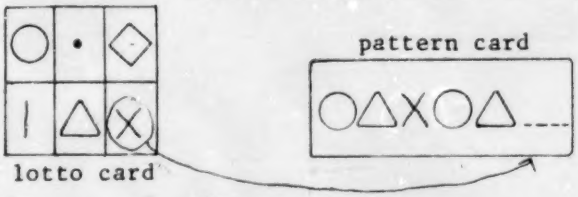
G. To increase understanding of patterns

Patterns are included here because they help the child develop logical thought processes. These experiences are a basis for higher mathematical learning. Always have the child read patterns from left to right. For further suggestions see Nurturing Intellectual Talent in Early Childhood.

1. Introduce the child to the concept of patterns by having him/her finish several that you have started. Encourage him/her to make up new patterns using the same materials whenever he/she completes a pattern which you have begun. Have the child make up patterns using common objects such as shoes (), keys ( ), scissors (), spools (), etc.

2. Have the child string beads in a pattern to make a necklace or have him/her paste a pattern made of gummed stickers or colored paper feathers on an Indian headband.

3. Play a pattern lotto game. Show the child the beginning of a pattern and have him/her find the next member of the pattern on his/her lotto card:



4. Have the child draw patterns using a row of dots:

If the child has difficulty, demonstrate the activity at first and vocalize as you draw the lines:

"over, under, over, under"

For more pattern suggestions, see Mathematics Their Way, by Baratta-Lorton, 1976.

H. To increase understanding of fractions

Fractions are a difficult concept for most preschoolers to comprehend. Help the child become familiar with the vocabulary of fractions. Introduce him/her to the terms "whole" and "part" before you use more technical words such as "half," "fourth," etc. Most young children understand "half" as something being divided into parts long before they realize that the parts are equal.

1. Introduce the concept of "half" in problem solving situations. For example, ask the child, "How can you divide this piece of toast so that you and Aaron each have the same size piece?" or "Divide this horse pen so that each horse has the same size space to run in." When the child has successfully halved an object, respond using the word "half." "You cut the piece of toast in half. Here's one half and here's the other half."
2. Play "telephone orders." Pretend that you are a shopper making orders over the phone to be delivered. Have the child take your order and deliver it to you. Ask for such things as a whole apple, half of a sheet of paper, etc.

I. To increase understanding of time

1. Have the child help you make a map of the neighborhood within short walking distance of the school. Have the child choose several

destinations where she/her wants to walk. With a stopwatch record how long it takes to get to each destination. Record this information on a chart or bar graph.

2. Have the child help make a large cardboard clock with enough space between the numerals to mount photographs taken of the class during a typical day at school. For example between the numerals eight and nine paste pictures of the children arriving, hanging up coats, etc. If possible, allow the child to take the pictures with a polaroid camera and mount them on the clock herself/himself.

3. Everyday ring a bell five minutes before the end of the same activity (outdoor play, snack, free play, etc.). Announce that the children have five minutes for that activity. This will help children develop a sense of how long five minutes are.

4. Time long-range events such as growing seeds. Tell the child how many days it will take for the sprouts to show, then help him/her mark the days on a calendar or chart.

5. Have the child run through an obstacle course several times, and time his/her speed with a stop watch. Before each turn, have him/her predict if he/she will run through the course faster or slower that time.

J. <u>To increase understanding of measuring space, volume and weight</u>

1. Challenge the child with the following measurement problems:

a. "How far is it across the room? How can you find out?" The child might mark the distance with footsteps, string, or other markers, or he/she might use a measuring stick to determine the measurement.

b. "Which is taller--the block tower on this side of the room or the one over there?" The child might compare the two heights to his/her own height or use string, tape or a measuring stick. Or he/she might move one tower so that it is next to the other and compare their heights.

c. "Will this table fit through the doorway?" The child might compare the width of the doorway and the width of the table, or he/she might bring the table up to the doorway to see if it is wider.

d. "Who is shorter than you? taller? the same height?" Challenge the child to use several ways to compare heights. He/she might stand next to other children to compare heights, mark various heights on the wall or use a measuring stick to see how tall each child is.

e. "Which of these two trees if bigger around (perimeter)?" The child might use adhesive tape, string or a measuring tape to compare perimeters, or he/she might wrap his/her arms around each of the trees.

2. Have the child measure distances that other children broad jump, heights that they high jump, or distances that they throw a ball.

3. Give the child strips of paper to construct a paper road for toy cars and trucks. Have the child measure the separate strips. Put the strips together and have the child find the total length of the highway. He/she might either add the lengths of the separate strips or measure the total length of the highway.

4. Have races with toy cars or marbles. Then measure the distance the cars or marbles travel.

5. Challenge the child with the following weighing problems:

   a. Do ten blocks weight the same as ten crayons?" If two scales are available, the child might weigh both groups of objects at the same time and compare them, or he/she might weight and record the weights of each set of objects separately and then compare the recorded weights.

   b. "Does one cup of rice weigh the same as one cup of flour?" Have the child predict before he/she weights the two volumes.

6. Have the child find two objects in the room and predict which is heavier. Then have him/her weight the objects to see if he/she guessed correctly.

7. Have one child stand on a scale. Then have another child predict how many blocks, books, etc. weigh the same as the child standing on the scale. Repeat the activity using various objects.

8. Fill three paper sacks with one pound, three pounds and five pounds of rice, sand or some other material. Write the weight of each sack on a separate index card. Have the child pick up the sacks and guess which bag goes with which card. Have the child verify his/her answer by weighing the sacks on a scale. Modify the activity by making the sacks more similar in weight, and by indicating the weights in pounds and ounces on the cards.

9. Challenge the child with the following volume problems:

   a. Which holds more water--this cup or this bowl? How can you find out?" The child might measure the amount of water held by each container in a separate container, or he/she might pour the water from the cup to the bowl and see if there is space left or if the water overflows. This concept might be very confusing for a preschooler. Young children often confuse volume and shape. For example, even after testing the two containers a child might insist that a tall, narrow one cup container holds more than a short, wide one cup container. Provide many opportunities for the child to repeat this type of activity.

   b. "Does a one liter container hold the same amount of water and same amount of milk?" The child might pour one liter of water and one liter of milk into another container to see if they are still the same.

   c. "There are six cups of juice in this pitcher and five people at this table. If each of us wants one cup of juice, will there be

enough?" Have the child make a prediction before he/she tests this problem.

K. To increase understanding of money and money values

1. Make a circle on the floor with masking tape. Explain to the child that the circle is a tollroad. Use a piece of cardboard for the tollbooth. Mount several coins on cardboard and when the child passes the tollbooth tell him/her to point to the correct coin you ask for. To make the task more difficult have the child tell you the amount the coin or coins are worth.

2. Have the child make and sell snack to the other members of the class. Have the child be the cashier and ask for the correct amount of money needed to buy the snack.

3. Set up a play store with the child. Attach price tags to all the items in the store. Keep the price of each item low, 1¢ through 3¢, so that the child can add prices and make change. Have the child play the cashier and sell items to other children.

ANNOTATED LIST OF RESOURCES

1. Baratta-Lorton, M. Mathematics their way. Menlo Park, California: Addison-Wesley Publishing Company, 1976.

   This book offers suggestions for helping children understand patterns of mathematics using manipulative materials. Patterning activities are used to help the child comprehend sorting and classifying, rote and meaningful counting, shapes, time, making graphs, comparing, adding and subtracting, place value and measuring. The activities allow for much creativity on the part of each child.

2. Behrmann, P., and Millman, J. How many spoons make a family? San Rafael, California: Academic Therapy Publications, 1971.

   The authors of this book of activities feel that math can be more meaningful to the young child when presented within the context of the child's natural environment. This book contains many good activities in a gamelike atmosphere.

3. Bereiter, C. Arithmetic and mathematics. San Rafael, California: Dimensions Publishing Company, 1968.

   This is an excellent book of methods and activities for making mathematics more understandable for children. The author believes that most people do not understand the principles behind math operations, nor do they see the connection between different kinds of math operations. Bereiter presents concrete ways to make math seem real and usable, beginning with the basics. The chapters cover such topics as: counting, measurement, math notation, numerical operations, numerical relationships, place value, one-to-one correspondence, geometry, teaching methods and what parents can do to help their children.

4. Byrdegaard, N. and Inskip, J. E., Jr. Mathematical experiencing. Washington, D.C.: American Association of Elementary - Kindergarten - Nursery Educators, 1972.

   This booklet may be very helpful for teachers in open classroom situations. It encourages a non-structured approach to teaching the basics of mathematics. The authors give numerous examples of how young children learn the fundamentals of geometry, number values and measurement through play and exploration. They emphasize that the teacher's responsibility is to provide adequate learning materials and create an atmosphere where children are free to explore and discover mathematics principles on their own.

5. Copeland, R. W. How children learn mathematics. New York: The MacMillan Company, 1970.

This book is based on Piaget's theories of learning. Using these theories, the author attempts to serve two purposes: assess what stage of mathematics a child is ready for and help the teacher arrive at a suitable teaching method. Among the mathematical topics ocvered are: classification, numbers, addition and subtraction, multiplication and division, logical thinking, space, geometry, and measurement. For each topic, Copeland explains how well children at various stages understand the principles involved and resultant teaching implications.

6. DeVries, R. and Kamii, C. Piaget, children and number. Washington D.C.: National Association for the Education of Young Children, 1976.

Kamii and DeVries take Piaget's theory concerning the nature of number and apply it to teaching math to preschoolers. The book contains: 1) a brief description of Piaget's theory of numbers, 2) principles of teaching number and 3) activities conductive to incidental learning of the nature of number.

7. Gallagher, J. J. Teaching the gifted child. Boston, Massachusetts: Allyn and Bacon, Inc., 1975.

The section "Mathematics for the gifted" emphasizes presenting students with concepts more abstract than those generally provided for the average student. While most of the activities in this book would be too high level for preschoolers this book contains excellent background information concerning gifted children of all ages.

8. Hlavaty, J. H. Enrichment mathematics for the grades. Washington, D. C.: The National Council of Teachers of Mathematics, Inc., 1963.

This yearbook presents various articles on enrichment activities specifically for children talented in math. Most of the activities would be too difficult for preschoolers, however, the first article "Some perspectives in Education" gives a good synopsis of the rationale for providing learning experiences in mathematics for talented children during the early school years.

9. Karnes M. B. Goal Program: Mathematical Concepts. Springfield, Massachusetts: Milton Bradley Company, 1973.

This is a game-oriented math program designed for children from ages three to five. The units include shapes, sets and one-to-one matching, whole numbers and rational counting, numerals, addition and subtraction, measurement, and patterns and progressions. Each unit is made up of several lessons with stated objectives and activities which involve the child actively.

10. Leeper, S. H., Dales, R. J., Skipper, D. S. and Witherspoon, R. L. Good schools for young children. New York: MacMillan Publishing Co., Inc., 1974.

The mathematics section of this book emphasizes that young children should learn math concepts in real life situations so that the basics of math make sense to them. Leeper includes many suggestions for introducing number, measurement, one-to-one correspondence, time, etc. in concrete ways. There is also a list of children's books which deal with math concepts.

11. Marzollo, J. and Lloyd, J. Learning through play. New York: Harper and Row Publishers, 1972.

This is an excellent book to recommend to parents. It suggests many simple parent/child activities which can be incorporated into daily life chores such as laundry, meal preparations and getting dressed. In the math-related section the main emphasis is on helping children understand concepts of ordering, sorting, counting, measuring and telling time, and becoming creative thinkers by solving problems, thinking of new ways to group objects, etc.

12. Smith, J. A. and Westcott, A. M. Creative teaching of mathematics in the elementary school. Boston, Massachusetts: Allyn and Bacon, Inc., 1967.

This book takes the basic principles of creativity and applies them to teaching mathematics at the elementary school level. While many of the activities may be too advanced for the preschooler, the book contains an excellent overview of the creative process and its application to mathematics programs.

13. Spodek, B. Teaching in the early years. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1972.

This textbook includes a chapter, "Mathematics for Young Children," which stresses the importance of using realistic experiences in the environment to make math more meaningful for young children.

14. Stanley, J. C., Keating, D. P. and Fox, L. H. Mathematical talent: Discovery, description and development. Baltimore, Maryland: John Hopkins University Press, 1974.

This book presents nine separate papers concerning the outcomes of the Study of Mathematic and Scientific Precocious Youth. While most of this book deals primarily with twelve to fourteen-year-olds, the first article of this book gives a good history of work with the gifted.

15. Steffe, L. P. Research on mathematical thinking of young children. Reston, Virginia: The National Council of Teachers of Mathematics Inc., 1975.

This book contains six empirical studies investigating the mathematical thinking of children in the age range of four to eight.

16. Stern, C., Stern, B. and Gould, T. S. Structural arithmetic for kindergarten. Boston, Massachusetts: Houghton Mifflin Company, 1966.

This book presents a carefully programmed sequence of demonstrations, experiments and games to teach mathematical concepts. In addition, there are experiments and enrichment activities designed to meet the needs of the gifted child.

17. Throop, S. Mathematics for the young child. Belmont, California: Lear Siegler, Inc./Fearon Publishers, 1974.

This booklet contains motivating activities for early math experiences. The activities reflect the experiential learning approach and make use of ordinary manipulative materials. The math areas covered are: making comparisons, mathematical vocabulary, time, fractions and counting.

18. Walton, J. Logical mathematical thinking and the preschool classroom. College Park, Maryland: Head Start Regional Resource and Training Center, 1974.

This booklet suggests activities to help children discover basic mathematics concepts. Walton includes many example dialogues which illustrate how to ask questions which will stimulate creative math thinking and how to respond to a child's "incorrect" statements in a way that encourages further investigation. For example, child: "I have 200 pegs!"; adult: "You sure do have a lot. Count them!".